

# What is the relationship between whole grain intake and body weight?

## Conclusion

Moderate evidence shows that intake of whole grains and grain fiber is associated with lower body weight.

## Grade: Moderate

Overall strength of the available supporting evidence: Strong; Moderate; Limited; Expert Opinion Only; Grade not assignable For additional information regarding how to interpret grades [click here](#).

## Evidence Summary Overview

Seven articles met the inclusion criteria and were reviewed to determine the effect of whole grain consumption on body weight, body mass index (BMI) and measures of adiposity. Of these studies, one was a systematic review (Williams PG et al, 2008), one was a systematic review/meta-analysis (Harland JI and Garton LE, 2007), two were RCTs (Behall KM et al, 2006; Katcher HI et al, 2008) and three were cross-sectional studies. Of the seven articles, five were of positive quality (Behall KM et al, 2006; Harland JI and Garton LE, 2007; Lutsey PL et al, 2007; Van de Vijver LP et al, 2009; Williams PG et al, 2008 ) and two were of neutral quality (Katcher HI et al, 2008; McKeown NM et al, 2009).

Both systematic reviews found that whole grains were associated with lower BMI and protected against weight gain and adiposity. Harland and Garton (2007) reviewed 15 observational trials that included a total of 119,829 subjects. Pooled analysis of high vs. low whole grain intake, using a random-effects model, found a combined and weighted mean difference in BMI of 0.630 kg/m<sup>2</sup> (P<0.0001). They also found reduced waist circumference (P=0.03) and lower waist:hip ratio (P=0.0001) with higher whole grain intakes. The authors concluded that a higher intake of whole grains (approximately three servings per day) was associated with lower BMI and central adiposity. Williams PG et al, (2008) found that 10 of 11 studies of dietary patterns reported that diets including higher whole grain intakes were associated with lower measures of obesity; two RCTs found greater weight loss with the whole grain intervention, while three RCTs showed significant weight loss in both interventions; three out of four observational studies reported greater weight loss with higher whole grain intake. The authors concluded that there was strong evidence that a diet high in whole grains was associated with lower BMI, smaller waist circumference and reduced risk of being overweight.

The randomized controlled feeding trial (Behall KM et al, 2006) compared the effects of three whole grain diets on blood pressure with weight as an ancillary outcome. Subjects (N= 25) consumed a controlled Step I diet for two weeks after which approximately 20% of energy was replaced with whole wheat or brown rice, barley or half wheat-rice and half barley, for five weeks each. Subjects lost approximately 1 kg during the study (P<0.01). In the RCT by Katcher et al (2008), subjects were told either to avoid whole grains foods or obtain all of their grain servings from whole grains for 12 weeks. Body weight, waist circumference and percentage body fat decreased significantly in both groups over the study period, but there was a significantly greater decrease in percentage body fat in the abdominal region in the whole grain group compared to the refined grain group.

The three cross-sectional studies consistently found that whole grain intakes were associated with lower BMI and adiposity. Analysis of a MESA study cohort of 5,496 men and women comparing the extreme quintiles of whole grain intake found a mean difference in BMI of  $0.6\text{kg/m}^2$  ( $P<0.0001$ ) (Lutsey et al, 2007). Similarly, McKeown et al (2009) found that in older adults, after multivariate adjustment comparing the extreme quartiles of consumption, whole grain intake was inversely associated with BMI ( $P=0.08$ ), percent body fat ( $P=0.02$ ) and percent trunk fat mass ( $P=0.02$ ) measured by whole-body dual-energy X-ray absorptiometry. In the Netherlands, Van de Vijver et al (2009) assessed the association of whole grain and cereal fiber intake with BMI and the risk of being overweight in older adults. They reported an inverse association between whole grain consumption and BMI. Fiber and cereal fiber intake were inversely associated with BMI in men only.

## **Evidence Summary Paragraphs**

### **Systematic Reviews (2)**

**Harland JI and Garton LE, 2007** (positive quality), a systematic review and meta-analysis conducted in the United Kingdom, examined the relationship between whole grain consumption and body weight. The review included 15 observational trials published between 1990 and 2006 that reported whole grain consumption, an appropriate control group and measures of body weight and adiposity. Subjects included a total of 119,829 males and females, aged 13 years or older. Pooled analysis of high vs. low whole grain intake, using a random-effects model, found a combined and weighted mean difference in BMI of  $0.630\text{kg/m}^2$  (95% CI:  $0.460, 0.800\text{kg/m}^2$ ;  $P<0.0001$ ). In subjects with higher whole grain intakes (six data sets,  $N=4,178$ ), waist circumference was reduced by 2.7 cm (95% CI:  $0.2, 5.2$ ,  $P=0.03$ ). In four data sets ( $N=20,417$ ), higher whole grain intake was associated with a lower waist:hip ratio of 0.023 (95% CI:  $0.016, 0.030$ ,  $P=0.0001$ ). The authors concluded that a higher intake of whole grains (approximately three servings per day) was associated with lower BMI and central adiposity.

**Williams PG et al, 2008** (positive quality), a systematic review conducted in Australia, evaluated existing evidence regarding the role of cereal grains and legumes in the prevention or management of overweight and obesity. A total of 53 studies met the inclusion criteria for review; 20 examined whole grain intake. Of those, 10 of 11 studies of dietary patterns found that diets that included higher whole grain intakes were associated with lower measures of obesity. Of five RCTs that included a whole grain were reviewed and results were mixed with two studies reporting greater weight loss in the whole grain intervention and three studies showing significant weight loss in both interventions. Three of four observational studies reported greater weight loss with higher whole grain intake. The authors concluded that there was strong evidence that a diet high in whole grains was associated with lower BMI, smaller waist circumference and reduced risk of being overweight.

### ***Randomized Controlled Trials (2)***

**Behall KM et al, 2006** (positive quality), a randomized, controlled crossover feeding trial conducted in the United States, compared the effects of three whole grain interventions on blood pressure. Weight was an ancillary outcome. Subjects ( $N=25$ ; seven males, nine premenopausal and nine postmenopausal women) consumed a controlled Step I diet for two weeks after which approximately 20% of energy was replaced with whole wheat and brown rice, barley, or half wheat-rice and half barley for five weeks each. Blood pressure was measured weekly and weight taken daily before breakfast. Replacing refined grain foods with whole wheat, barley or brown rice products lowered blood pressure and maintained or lowered body weight while increasing energy intakes ( $P<0.0138$ ) in overweight or obese subjects. Although the energy intakes were adjusted weekly to maintain weight, subjects lost about 1kg during the study ( $P<0.01$ ). The authors concluded that increasing whole grain foods may help to control weight.

**Katcher HI et al, 2008** (neutral-quality), an RCT conducted in the United States, examined 50 obese men and women with metabolic syndrome who received dietary advice either to avoid whole grain foods or obtain all of their grain servings from whole grains for 12 weeks. All participants were given the same dietary advice in other respects for weight loss. Forty-seven subjects completed the study (94%). Body weight, waist circumference and percent body fat decreased significantly in both groups over the study period ( $P<0.001$ ), but there was a significantly greater decrease in percentage body fat in the abdominal region in the whole grain group ( $P=0.03$ ). Total, LDL and HDL-cholesterol decreased in both diet groups ( $P<0.05$ ).

### ***Cross-sectional Studies (3)***



**Lutsey PL et al, 2007** (positive quality), a cross-sectional study conducted in the United States, examined the association between whole grain intake and obesity, selected CVD risk factors and measures of subclinical atherosclerosis using baseline data from the Multi-Ethnic Study of Atherosclerosis (MESA Study). Subjects included 5,496 men and women free of CHD and previously known diabetes. A 127-item FFQ was used to obtain dietary information, including whole grain intake. Mean whole grain intake was 0.5 servings per day. After multivariate adjustment, the mean difference in BMI for the extreme quintiles of whole grain intake was  $0.6 \text{ kg/m}^2$  ( $P<0.0001$ ). The authors concluded that there were strong cross-sectional associations between whole grain consumption and BMI.


**McKeown NM et al, 2009** (neutral quality), a cross-sectional study conducted in the United States, examined the associations between whole and refined grain intake, dietary fiber and fiber sources, and body fat among older adults. Subjects included 434 free-living adults (177 men, 257 women) aged 60 to 80 years. Dietary intake was estimated from a 126-item semi-quantitative FFQ. Percent body fat and percent trunk fat mass were measured by whole-body dual-energy X-ray absorptiometry (DXA). After multivariate adjustment comparing the extreme quartiles of consumption, whole grain intake was inversely associated with BMI ( $26.8 \text{ kg/m}^2$  vs.  $25.8 \text{ kg/m}^2$ ;  $P=0.08$ ), percent body fat ( $34.5\%$  vs.  $32.1\%$ ;  $P=0.02$ ) and percent trunk fat mass ( $43.0\%$  vs.  $39.4\%$ ;  $P=0.02$ ). Cereal fiber was also inversely associated with BMI, body fat and trunk fat mass. The authors concluded that higher consumption of whole grains, and consequently cereal fiber, was associated in a dose-dependent manner with a significantly lower BMI and percentage of abdominal fat as determined by DXA.



**Van de Vijver LP et al, 2009** (positive quality), a cross-sectional study conducted in the Netherlands, examined the associations between whole grain and cereal fiber intake with BMI and the risk of overweight or obesity (BMI higher than 25 to  $30 \text{ kg/m}^2$ ). The study included 4,237 subjects (2,078 men and 2,159 women) aged 55 to 99 years. Multivariate regression analysis found an inverse association between whole grain consumption and BMI, as well as with the risk of overweight and obesity. The associations were stronger in men than in women. For each additional gram of (dry) whole grain intake, obesity risk was 10% lower for men and 4% lower for women. Fiber and cereal fiber intake were inversely associated with BMI in men only. The authors concluded that whole grain consumption might be protective against overweight or obesity, although the cross-sectional study design did not allow conclusions about the causality of the association.

 [View table in new window](#)



Author, Year,	Participants,	Description of	Outcomes	Whole Grain
---------------	---------------	----------------	----------	-------------

Study Design, Class, Rating	Duration and Location	Study Design		Definition
<p>Behall KM, Scholfield DJ et al, 2006</p> <p>Study Design: Non-Randomized Crossover Trial</p> <p>Class: A</p> <p>Rating: </p>	<p>N = 25; seven males, nine pre- and nine post-menopausal women.</p> <p>Location: United States.</p>	<p>Examined the effects of three whole grain feeding interventions on blood pressure (BP).</p> <p>Subjects consumed a controlled Step I AHA diet for two weeks after which refined grains (approximately 20% of energy) were replaced with whole wheat or brown rice, barley, or half whole wheat-rice and half barley, for five weeks each.</p> <p>BP was measured weekly and weight taken daily before breakfast.</p>	<p>Weight loss approximately 1kg during whole grain interventions (P&lt;0.01).</p> <p>Energy intakes were significantly ↑ (average 100kcal) with the three whole grain diets than with the Step I diet. (P &lt;0.036).</p> <p><i>Note: Fiber was not examined.</i></p>	<p>Planned dietary interventions with whole wheat, whole barley or brown rice products.</p>
<p>Harland JI and Garton LE, 2008</p> <p>Study Design: Meta-analysis or Systematic Review</p> <p>Class: M</p> <p>Rating: </p>	<p>N=15 observational trials.</p> <p>Pooled analysis.</p> <p>N=119,829 males and females.</p> <p>Age: 13+ years.</p> <p>Location: United Kingdom.</p>	<p>Review and pooled analysis of whole-grain intake and body weight.</p> <p>Search dates: 1990 to 2006.</p> <p>Included observational trials that reported whole-grain consumption, an appropriate control group and measures using a random-effects</p>	<p>Combined and weighted mean difference in BMI = 0.630kg/m<sup>2</sup> (95% CI: 0.460, 0.800kg/m<sup>2</sup>; P &lt;0.0001).</p> <p>Waist circumference reduced by 2.7cm (95% CI: 0.2, 5.2, P=0.03) in subjects with higher whole grain intakes (six data sets, N=4,178).</p>	<p>Varied by study; most used the Jacob algorithm (Jacobs, 1998) to classify foods as whole or refined grain.</p> <p>Brand of cereals consumed resulted in classification of whole grain or refined grain.</p>

		model.	<p>Waist:hip ratio ↓ by 0.023 (95% CI: 0.016, 0.030; P=0.0001).</p> <p><i>Note: Fiber was not examined relative to outcomes. Authors stated that it's not clear if whole grain mechanism is fiber or a micro-component, such as lignin or phytosterol.</i></p>	Breakfast cereals containing at least 25% whole grain.
<p>Katcher HI, Legro RS et al, 2008</p> <p>Study Design: Randomized Controlled Trial</p> <p>Class: A</p> <p>Rating: </p>	<p>N=50 obese men and women with metabolic syndrome.</p> <p>Ages 20 to 65 year.</p> <p>47 subjects completed the study (94%).</p> <p>Location: United States.</p>	<p>Subjects received dietary advice to avoid whole grain foods or obtain all of their grain servings from whole grains for 12 weeks.</p> <p>All participants were given the same dietary advice in other respects for weight loss.</p>	<p>Body weight, waist circumference and percent body fat ↓ significantly in both groups from baseline (P&lt;0.001).</p> <p>Percent abdominal body fat ↓ in whole grain compared to refined grain intervention (P=0.03).</p> <p><i>Note: In addition to whole grains, the associated components - fiber and magnesium intake - differed significantly between the whole grain and refined grain groups. The authors did not draw conclusions related to these factors.</i></p>	<p>Whole grain group consumed approximately five servings per day.</p> <p>Whole grains were defined as "whole grain was first item on ingredient list."</p>

<p>Lutsey PL et al 2007</p> <p>Study Design: Cross sectional study</p> <p>Class: D</p> <p>Rating: </p>	<p>N=5,496 men and women.</p> <p>Location: United States.</p>	<p>Examined association between whole grain intake and obesity using baseline data from the Multi-Ethnic Study of Atherosclerosis (MESA Study).</p> <p>A 127-item FFQ was used to obtain dietary information, including whole grain intake.</p>	<p>The highest quintile of whole grain intake consumed 1.39 servings per day; the lowest quintile consumed 0.02 servings per day.</p> <p>Multivariate adjusted mean difference in BMI for the extreme quintiles of whole grain intake was 0.6kg/m<sup>2</sup> (P&lt;0.0001).</p> <p><i>Note: Fiber not examined.</i></p>	<p>Whole grains included whole grain breakfast cereal, oatmeal, dark bread, bran muffins, brown or wild rice.</p>
<p>McKeown NM, Yoshida M et al, 2009</p> <p>Study Design: Cross-sectional study</p> <p>Class: D</p> <p>Rating: </p>	<p>N=434 free-living adults (177 men, 257 women).</p> <p>Age: 60 to 80 years.</p> <p>Location: United States.</p>	<p>Examined association between whole and refined grain intake, dietary fiber and fiber sources and body fat among older adults.</p> <p>Semi-quantitative FFQ (126-item) used to estimate intake levels.</p> <p>Percent body fat and trunk fat mass measured with whole-body DEXA.</p>	<p>After adjustment for covariates, whole-grain intake was inversely associated with:</p> <p>BMI: 25.8kg/m<sup>2</sup> (95% CI: 24.6 to 27.1; P=0.08)</p> <p>Percent body fat: 32.1% (95% CI: 30.1 to 34.1%; P=0.02)</p> <p>Percent trunk fat mass: 39.4% (95% CI: 36.7 to 42.1; P=0.02).</p> <p><i>Note: Cereal fiber was also inversely associated with BMI. Total fiber was not.</i></p>	<p>Whole grain estimated as grams per day using a food composition database for whole grains.</p> <p>Whole grains included cooked and cold breakfast cereals, dark bread, brown rice, popcorn and other grains (e.g., bulgur, kasha and couscous).</p> <p>Breakfast cereal was considered whole grain if it contained 25% or more whole</p>




				grain or bran by weight.
<p>van de Vijver LP et al 2009</p> <p>Study Design: Cross-sectional</p> <p>Class: D</p> <p>Rating: </p>	<p>N=4,237 subjects (2,078 men and 2,159 women).</p> <p>Age: 55 to 69 years.</p> <p>Location: Netherlands.</p>	<p>Examined associations between whole-grain and cereal fiber intake with BMI and the risk of overweight or obesity (BMI of 25 to 30kg/m<sup>2</sup> or more) using multivariate regression analysis.</p> <p>Whole grain intake calculated in mean daily intake (grams per day).</p>	<p>Obesity risk for each additional 1g intake of whole grain intake (dry weight):</p> <p>Men: OR=0.90; 95% CI: 0.84, 0.98; P&lt;0.01.</p> <p>Women: OR=0.96; 95% CI: 0.93, 0.99; P&lt;0.01.</p> <p>Each SD ↓ in BMI corresponded to a 33g per day increase in whole grain intake (dry weight).</p> <p><i>Note: Fiber and cereal fiber intake were inversely associated with BMI in men only.</i></p>	<p>The variable 'all grain' calculated as sum of bran, wheat germs, muesli, porridge (oats or whole wheat), brown rice and cooked grains.</p> <p>Dry weight of porridge, brown rice and cooked grains calculated to prevent unbalanced weighting to the sum score.</p> <p>'Whole grain' variable did not include bran and wheat germ.</p>
<p>Williams PG et al 2008</p> <p>Study Design: Systematic Review</p> <p>Class: M</p> <p>Rating: </p>	<p>N=53 studies; only 20 studies examined whole grain intake.</p> <p>Location: Australia.</p>	<p>Examined existing research to assess the role of cereal grains and legumes in the prevention or management of overweight and obesity.</p> <p>Search date: 1980 to 2005.</p> <p>Limited to English language and studies that reported</p>	<p>Ten of 11 studies of dietary patterns found that diets that included higher whole grain intakes were associated with lower measures of obesity.</p> <p>Five RCTs with a whole grain intervention were reviewed. Results were mixed: Two studies reported</p>	<p>Varied by study; most used the Jacob algorithm (Jacobs, 1998) or FDA health claim criteria to classify foods as whole or refined grain.</p>

		<p>anthropometric outcome measures.</p> <p>European Heart Network criteria used to assess scientific quality.</p>	<p>greater weight loss in the whole grain intervention; three studies reported significant weight loss in both interventions.</p> <p>Three of four observational studies reported greater weight loss with higher whole grain intake.</p> <p><i>Note: Authors stated that while dietary fiber appears strongly inversely associated with body weight and weight gain, not all of the effect of whole grains may be explained by their fiber content.</i></p>	
--	--	---	--	--


## Research Design and Implementation Rating Summary


For a summary of the Research Design and Implementation Rating results, [click here](#).

## Worksheets


 [Behall KM, Scholfield DJ, Hallfrisch J. Whole-grain diets reduce blood pressure in mildly hypercholesterolemic men and women. \*J Am Diet Assoc\*. 2006 Sep; 106\(9\): 1,445-1,449.](#)


 [Harland JJ, Garton LE. Whole-grain intake as a marker of healthy body weight and adiposity. \*Public Health Nutrition\*. 2008 Jun; 11\(6\): 554-563.](#)


 [Katcher HI, Legro RS, Kunselman AR, Gillies PJ, Demers LM, Bagshaw DM, Kris-Etherton PM. The effects of a whole grain-enriched hypocaloric diet on cardiovascular disease risk factors in men and women with metabolic syndrome. \*Am J Clin Nutr\*. 2008; 87: 79-90.](#)

 [Lutsey PL, Jacobs DR Jr, Kori S, Mayer-Davis E, Shea S, Steffen LM, Szklo M, Tracy R. Whole grain intake and its cross-sectional association with obesity, insulin resistance, inflammation, diabetes and subclinical CVD: The MESA Study. \*Br J Nutr\*. 2007 Aug; 98\(2\):397-405.](#)



 [McKeown NM, Yoshida M, Shea MK, Jacques PF, Lichtenstein AH, Rogers G, Booth SL, Saltzman E. Whole-grain intake and cereal fiber are associated with lower abdominal adiposity in older adults. \*J Nutr\*. 2009 Oct; 139 \(10\): 1,950-1,955. Epub 2009 Sep 2](#)

 [van de Vijver LP, van den Bosch LM, van den Brandt PA, Goldbohm RA. Whole-grain consumption, dietary fibre intake and body mass index in the Netherlands cohort study. \*Eur J Clin Nutr\*. 2009 Jan;63\(1\):31-8. Epub 2007 Sep 26.](#)

 [Williams PG, Grafenauer SJ, O'Shea JE. Cereal grains, legumes, and weight management: a comprehensive review of the scientific evidence. \*Nutr Rev\*. 2008 Apr;66\(4\):171-82.](#)